



Cardiac Arrhythmias

Ass. Prof. Wessam Ezzat
Faculty of Medicine Ain Shams
University

INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture students will be able to:

1. Define and classify arrhythmia based on its origin.
2. List 2 mechanisms for tachyarrhythmias.
3. Describe the ECG changes in different types of arrhythmias.
4. Compare & contrast atrial flutter & fibrillation.
5. Mention the ECG findings in 2nd degree



Lecture Plan



1. Part 1 (5 min) Normal sinus rhythm & introduction to cardiac arrhythmias

2. Part 2 (35 min) main lecture

- ✓ Types of arrhythmias due to disturbance in impulse formation.
- ✓ Ectopic beats (types, causes & ECG findings)
- ✓ Types of supraventricular tachycardia
- ✓ Types of ventricular tachycardia
- ✓ An Example of arrhythmias due to disturbance in impulse conduction (Atrioventricular block)

3. Part 3 (5 min) Summary

4. Lecture Quiz (5 min)

CARDIAC ARRHYTHMIAS



•Def:

- Disturbance in either **rate** or **regularity** of the normal cardiac rhythm.
- **Normal sinus rhythm is** a regularly beating heart at a resting rate of 60-100 bpm, with each beat originating in the SA node and passing in the normal conductive pathway to activate the atria and then the ventricles.
- **The ECG picture of the normal sinus rhythm:**

Regular

Rate

60-100/min

**Normal
P wave**

**Normal
QRS complex**

**Normal P-R interval
(0.12-0.21 sec)**

One P for every QRS.

**Normal T wave
in the direction the QRS**

Classification of Cardiac Arrhythmia



Classification of arrhythmias

*Disturbance
in
Impulse
Formation*

**Alteration of SA node
activity**

AV nodal Rhythm

Presence of Ectopic foci

*Disturbance
in
Impulse
Conduction*

**Conduction
Block**

Accelerated AV conduction

I. Arrhythmias due to disturbance in impulse formation



Alteration of SA node activity

AV nodal Rhythm

Presence of Ectopic foci

tachycardia

- **Sinus bradycardia**

Ectopic beats (Extrasystoles)

- Supraventricular (PAC)
- Ventricular (PVC)

Ectopic Tachycardias
A) Supraventricular tachycardias:

- Paroxysmal Atrial Tachycardia
- Atrial Flutter
- Atrial Fibrillation (AF)

B) Ventricular Tachycardias:

II. Arrhythmias due to disturbance in impulse conduction



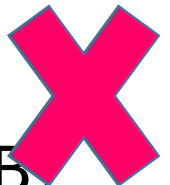
**Accelerated
AV
conduction**

Wolf-Parkinson-
White Syndrome
(WPW)



**Conduction
Block**

- Atrioventricular block (heart block)
- Bundle Branch Block (BBB)

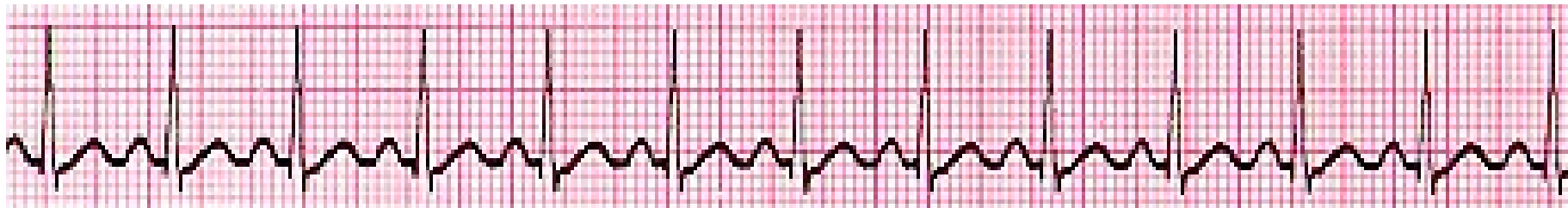


Alteration in SA node activity



- The SA node is still the only pacemaker, but there is a change in the rate of its discharge under the effect of cardiac autonomic nerves.

a) Sinus Tachycardia



- SA node fires **faster** than normal + impulse is conducted normally.
- ECG is normal except:
 - Duration of cardiac cycle (R-R interval) is shortened.
 - Rate **> 100** bpm
- **Causes:** Stress, emotions and exercise (↑ sympathetic activity), Hemorrhage, Hyperthyroidism,

Alteration in SA node activity

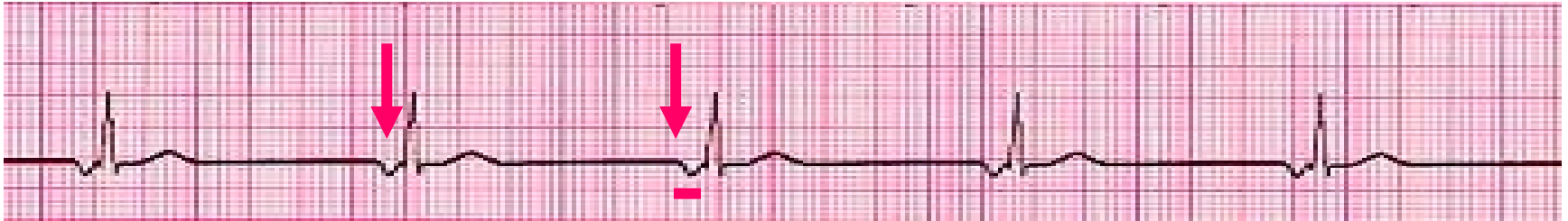


b) Sinus Bradycardia



- SA node fires **slower** than normal + impulse is conducted normally.
- ECG is normal **except:**
 - Duration of cardiac cycle (R-R interval) is lengthened
 - Rate **< 60** bpm
- **Causes:** During sleep and in athletes (\uparrow vagal tone), Hypothyroidism, Drugs (β - blockers & digitalis).

AV nodal rhythm



Cause:

the SA node is damaged or depressed.

ECG picture:

- a) Bradycardia □ $HR = 40-60/min.$
- b) Inverted P wave.
- c) Short P-R interval.
- d) Normal QRS complex and T wave.

What is meant by an ectopic ?focus



- ✓ An area of the heart that initiates an impulse without waiting for the SA node is called an ectopic focus.
- ✓ If the ectopic focus fires **once**, the result is a beat that occurs before the expected next normal beat and transiently interrupt the cardiac rhythm □ **premature beat (extrasystole)**.
- ✓ If the ectopic focus fires **repetitively** + higher than the SA node □ a sustained abnormal rhythm (**paroxysmal tachycardia**). Ectopic foci can occur in both healthy & diseased hearts.
- ✓ **Ectopic foci can occur in**
 - 1- the AV node & other parts of the His Purkinje system and become the pace maker of the heart.
 - 2- atrial & ventricular muscle fibers (non-pacemaker tissues) in abnormal conditions e.g ischemia

How to differentiate between supraventricular & ventricular tachycardia



Generally,



- **Supraventricular (atrial) ectopic activity/ tachycardia**
 - Abnormal P wave (inverted).
 - Normal QRS.
 - In addition, attacks of tachycardia are usually stopped by Valsalva maneuver , carotid sinus massage or oculo-cardiac reflex.

- **Ventricular ectopic activity/tachycardia :**
 - Absent P wave.
 - Abnormal QRS.
 - Not suppressed by the previous maneuvers



Ectopic beats or extrasystoles (Premature beats)



Def:

- Early abnormal systole produced by impulse discharged once from an ectopic focus during diastole (as the cardiac muscle during systole is in the ARP).
- So it is a contraction of the heart prior to the time of the expected normal contraction of the heart.

Cause:

• Physiologically in

- Stress
- Smoking
- Caffeine
- Pregnancy

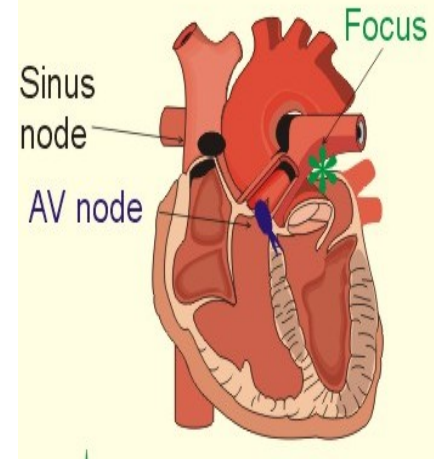
• Pathologically in

- myocardial ischemia.

Types:

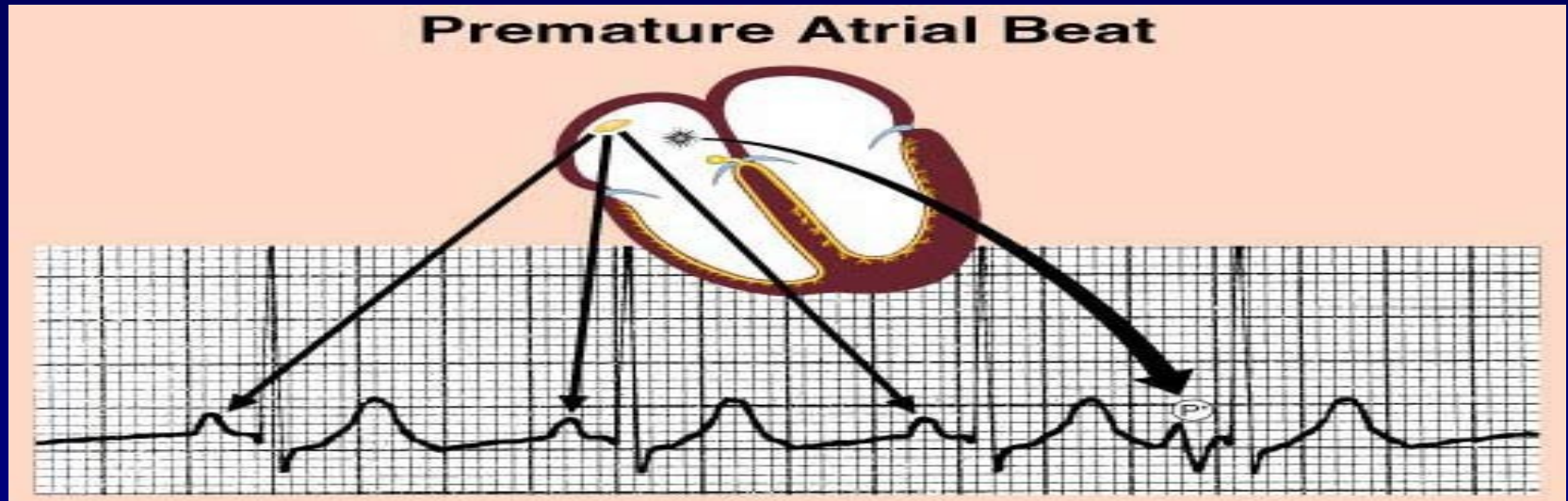
- 1- Premature Atrial Contraction (PAC).
- 2- Premature Ventricular Contraction (PVC).

Premature Atrial Contraction (PAC)



•ECG picture of PAC:

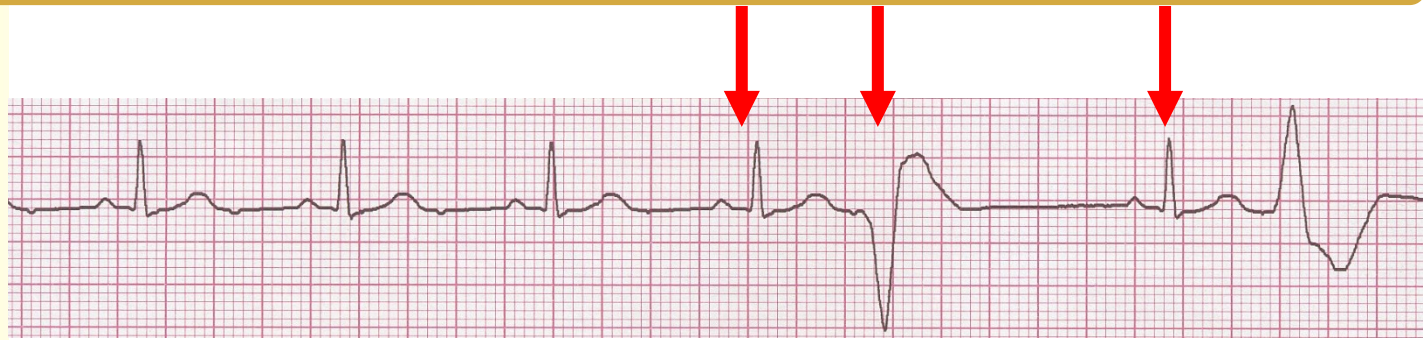
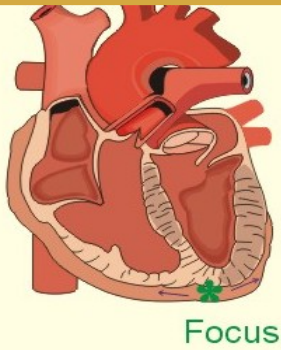
- P wave □ **abnormal** (as the atria are +ed from an E.F in the atria, not SA node) .
- QRS complex and T waves are **normal** (the impulse is conducted normally through the AV node and ventricles) .
- PAC may be followed by a **compensatory pause** (a prolonged interval between the premature contraction and the next normal contraction).



So,

Early bizarre P wave is essential for diagnosis of PAC.

Premature Ventricular Contraction (PVC)



ECG picture of PVC:

- P wave ☐ **absent** (as the E.F is in the ventricles & there is no retrograde conduction the atria).
- QRS complex ☐ abnormal QRS complex (**Bizzare shape**) wide (> 0.12 sec) & of high voltage
(due to the slow conduction of impulse in the ventricular muscles)
- T-wave ☐ **inverted** (as slow conduction of impulse in the cardiac muscle causes the area first depolarize also to repolarize first).
- PVC is followed by a **compensatory pause** (the normal SA node impulse after the ES find the ventricle still in the contraction of the ES (in the ARP) so will be ineffective and a CP is recorded).

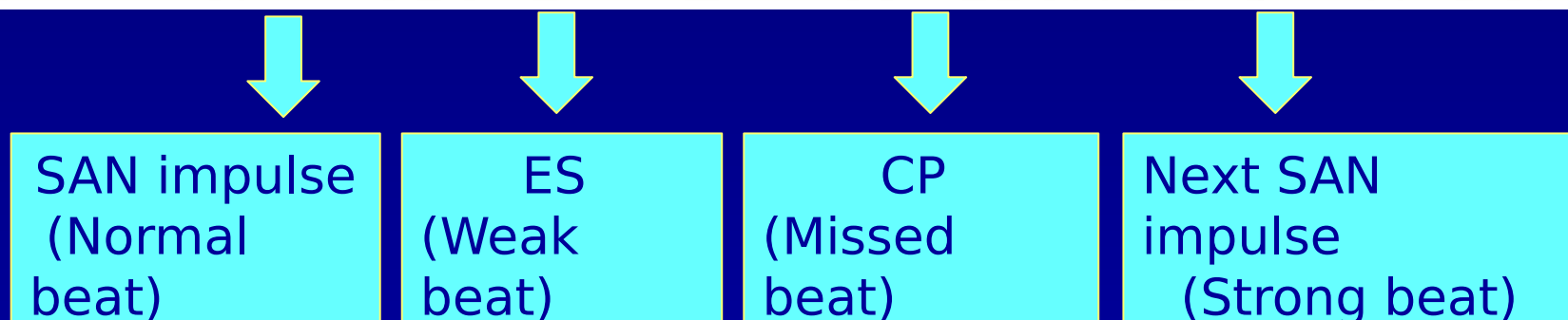
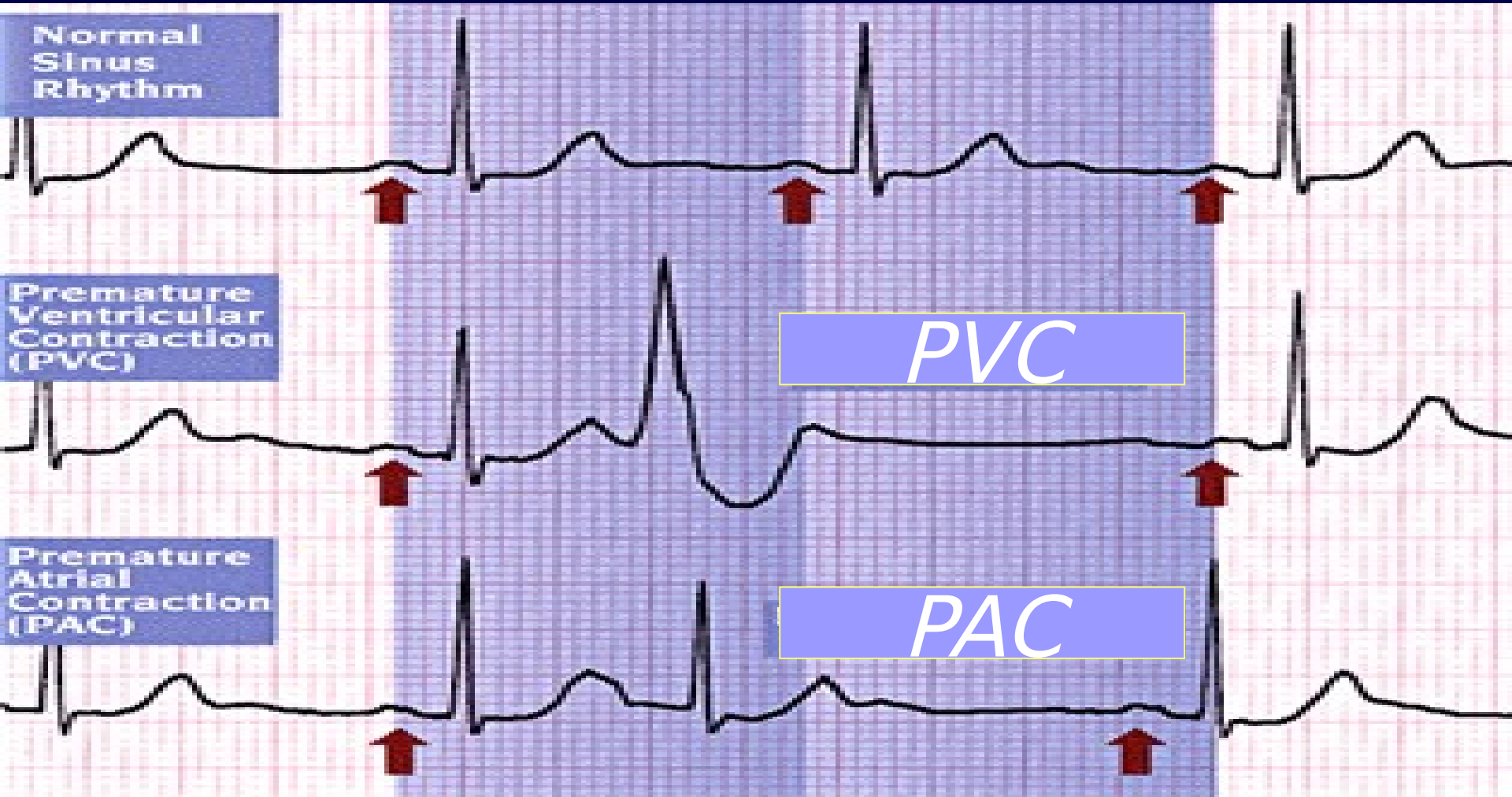
So,

Early bizarre QRS complex (>0.12 sec) is essential for diagnosis of PVC.



Note:

- The next SA node impulse produce a contraction stronger than normal (**Postextrasystolic potentiation**):
 - Due to more ventricular filling during the CP.
 - Due to more reuptake of Ca by the SR during the CP.



Ectopic Tachycardia

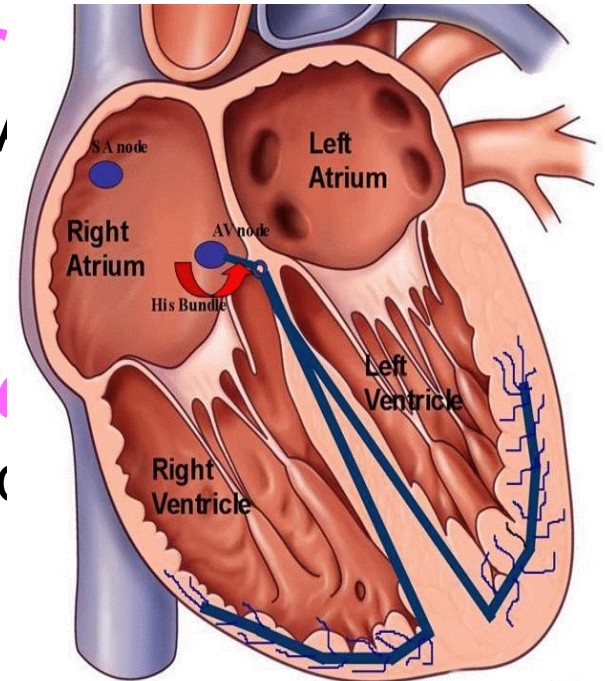


A) Supraventricular tachycardia

- Paroxysmal Atrial Tachycardia (PAT)
- Atrial Flutter
- Atrial Fibrillation (AF)

B) Ventricular Tachycardia

- Paroxysmal Ventricular Tachycardia (PVT)
- Ventricular Fibrillation (VF)



Mechanisms of ectopic tachycardias.

- 1- The reentry phenomenon & circus movement (more common).
- 2- Enhanced automaticity of an ectopic site.

Supraventricular Tachycardias



1- Paroxysmal Atrial Tachycardia (PAT)



- Attacks, very rapid onset, offset
- **regular** rates of **150 - 220** bpm.
- **Cause:**
 - * Reentry & circus movement.
 - * Hyperexcitable ectopic focus in the atria.
- **ECG:**
 - P wave □ **abnormal** (inverted), sometimes difficult to identify.
 - QRS and T wave □ **normal** (ventricular conduction is normal).
 - P-R interval □ shortened or absent.

Supraventricular Tachycardias



2- Atrial flutter:



3- Atrial fibrillation:

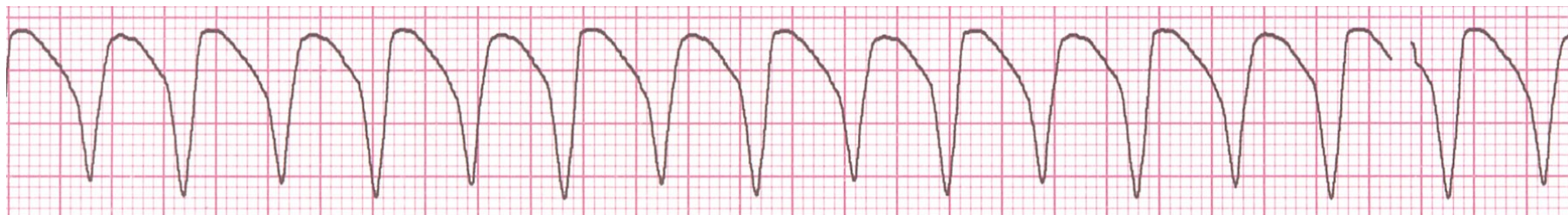


	Atrial flutter	Atrial fibrillation
Cause	<ul style="list-style-type: none"> - Single hyperexcitable ectopic focus in atria. - Reentry & circus movement. 	<ul style="list-style-type: none"> - Multiple hyperexcitable ectopic foci in atria. - Reentry & circus movement
Atrial rate	Regular , 250 - 350 bpm.	Irregular , 350-500 bpm
Ventricular rate	Regular , 125-175 bpm (d.t physiologic AV block)	Irregular , 100-150 bpm (d.t physiologic AV block)
AV block	At a constant rate 2:1 or 3:1	Not at a constant rate
Atrial contraction	-synchronous and efficient with normal cardiac output	asynchronous and non efficient with ↓ COP. "bag of worms"
ECG	<ul style="list-style-type: none"> - P wave □ abnormal in shape (flutter waves). 	<ul style="list-style-type: none"> - P wave □ absent & replaced by F waves which appear as an

Ventricular Tachycardias



1- Paroxysmal Ventricular Tachycardia (PVT):



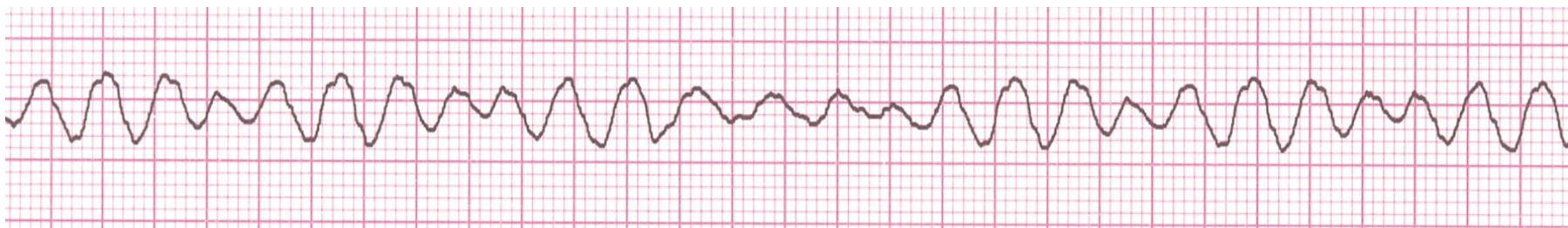
- Attacks, very rapid onset, offset.
- Regular rates of 150 - 200 bpm.
- **Cause:**
 - * Reentry & circus movement.
 - * Hyperexcitable ectopic focus in the
- **ECG:**
 - ventricle.
 - P wave □ **absent**
 - QRS complex □ slurred, notched, and wide = **bizarre shaped** (abnormal conduction in the ventricles).

Note: *It is a serious condition as ↓ filling time & ↓ cardiac output & may lead to ventricular fibrillation*

Ventricular Tachycardias



2- Ventricular Fibrillation (VT):



- Cause:

- * Myocardial ischemia
- * Paroxysmal ventricular tachycardia (PVT).
- *Ventricular fibrillation is the most frequent cause of sudden death in patients with myocardial infarction.*

ECG:

- Bizarre irregular rapid waves of varying frequency & amplitude □ irregular rhythm (**fibrillatory waves**) .
- The fibrillating ventricles can not pump blood effectively □ stoppage of circulation (No cardiac output + No peripheral pulse).
- Therefore, VF is **fatal** without emergency treatment.



Electric Defibrillation (Cardioversion)_

II. Arrhythmias due to disturbance in impulse conduction



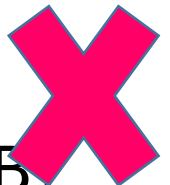
**Accelerated
AV
conduction**

Wolf-Parkinson-
White Syndrome
(WPW)



**Conduction
Block**

- Atrioventricular block (heart block)
- Bundle Branch Block (BBB)



Atrioventricular block (Heart block)



1st degree AV Block



- Delay in conduction of **all impulses** from the atria to the ventricles but with **NO** actual block.
- **ECG:**
Only, the P-R interval **> 0.21** sec.

Atrioventricular block (AV heart block)



2nd degree AV Block, Type I



- Progressive prolongation of PR interval, then the impulse is completely blocked

ECG:

- Progressive ↑ in PR interval, then P wave is not followed by QRS.

2nd degree AV Block, Type II



Not all atrial impulses are transmitted to the ventricle □ dropped beats.
i.e there is a ventricular beat following every second or every third atrial beat (2:1 or 3:1 block).

ECG:

- P wave not followed by QRS.

Ratio of P: QRS is **2:1 or 3:1**

New five year program

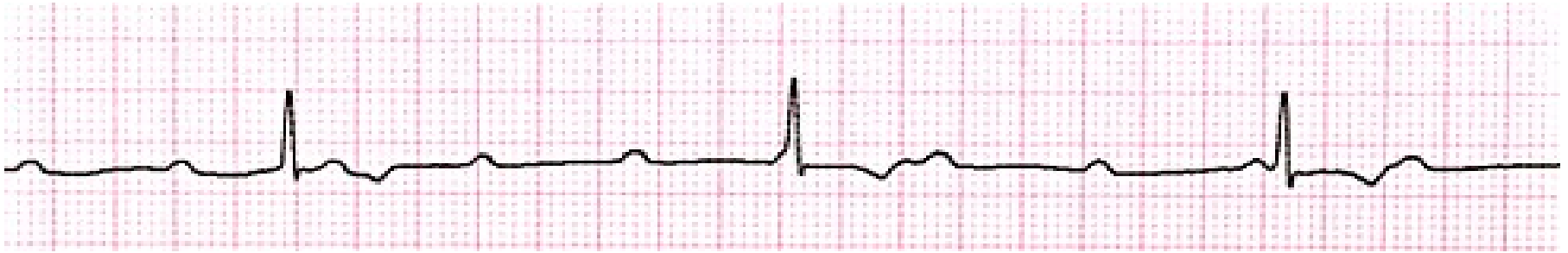
Cardio- pulmonary module

- No prolongation of PR interval.

Atrioventricular block (AV heart block)



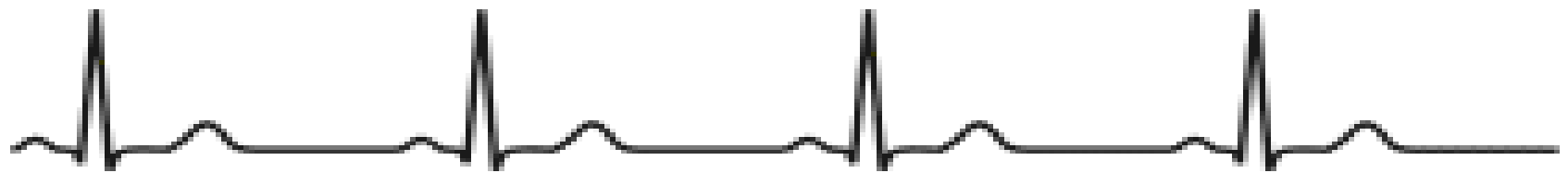
3rd degree AV Block = complete



- **All** atrial impulses are **completely** blocked in the AV junction.
- So the atria beat at a rate of 70 bpm (normal sinus rhythm), while the ventricles beat at a low rate **25- 45 bpm (idioventricular rhythm).**

ECG:

- P waves has no relation to QRS.
- QRS is □ normal as the pacemaker usually develop in the His bundle.



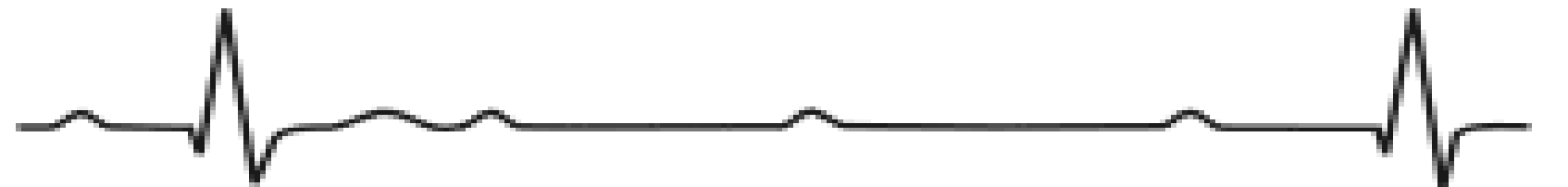
Normal



First-Degree AV Block

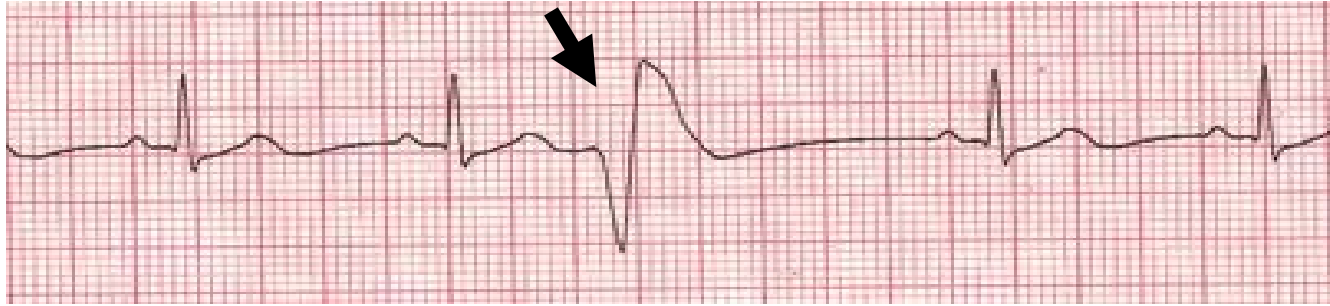


Second-Degree AV Block (2:1)



Third-Degree AV Block

Lecture Quiz

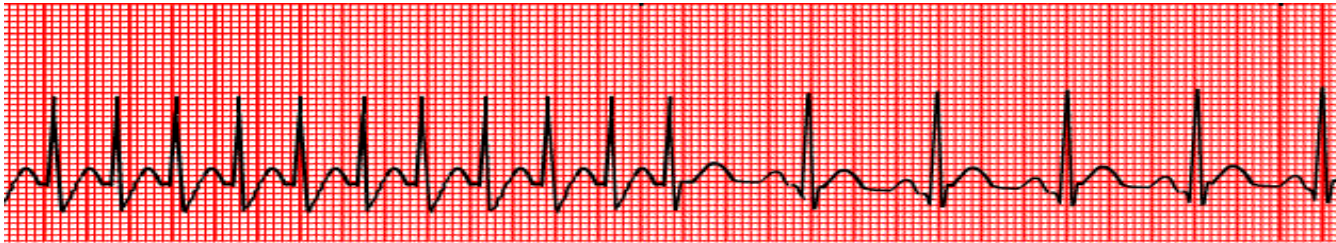


Premature ventricular Contraction (PVC)

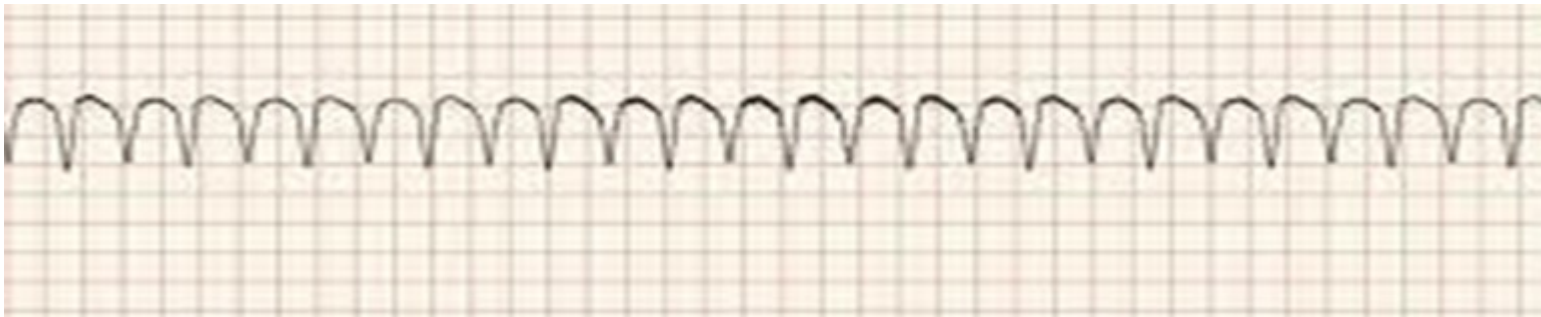


Premature Atrial Contraction (PAC)

Lecture Quiz

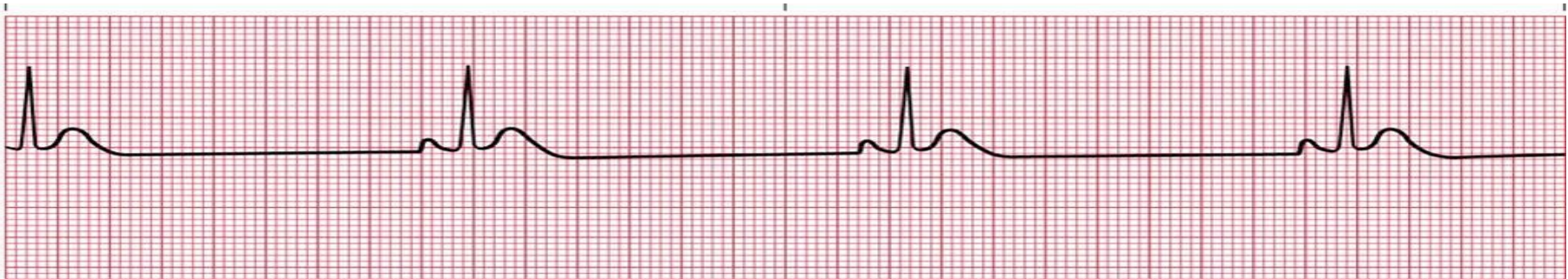


PAT

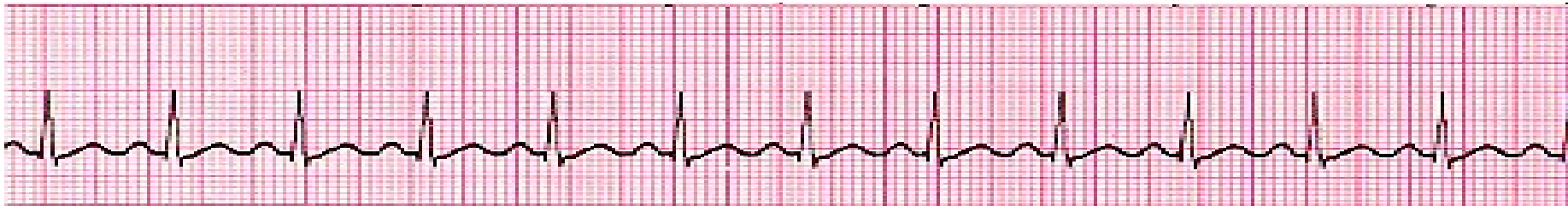


PVT

Lecture Quiz

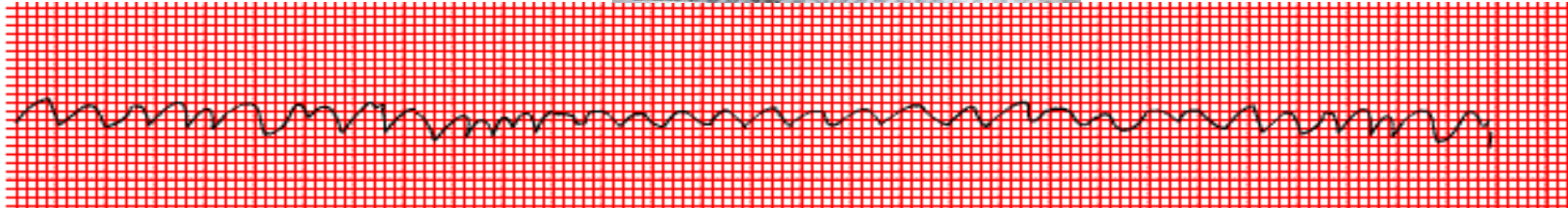


- **Sinus bradycardia**



- **Sinus tachycardia**

Lecture Quiz



VF



*Atrial
flutter*



2nd degree heart block type 1

SUGGESTED TEXTBOOKS



- 1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 13 , from page 147-156*
- 2. Ganong's Review of Medical Physiology, twenty-fifth edition 2016, McGraw-Hill Education, chapter 30, from page 497-500*



graphicsarcade.com